Text table 2-1.
U.S. R&D expenditures, by performing sector, source of funds, and character of work: 1998
(Millions of U.S. dollars)

	Performer						
Character of work/ sources of funds	Federal Government	Industry[a]	Universities and colleges	U&C associated FFRDCs[b]	Other nonprofit institutions[a]	Total	Percent distribution by sources
TOTAL R&D							
Federal Government	17,189	24,589	15,558	5,517	4,077	66,930	29.5%
Industry	..	146,706	1,896	..	1,051	149,653	65.9%
Universities and colleges	..	..	7,049	..	..	7,049	3.1%
Other nonprofit institutions	..	..	1,840	..	1,702	3,541	1.6%
Total.	17,189	171,295	26,343	5,517	6,830	227,173	100.0%
Percent distribution, performers	7.6%	75.4%	11.6%	2.4%	3.0%	100.0%	
BASIC RESEARCH							
Federal Government	2,920	1,816	11,248	2,721	1,531	20,235	53.4%
Industry	..	9,625	1,205	..	483	11,313	29.9%
Universities and colleges	..	..	4,479	..	..	4,479	11.8%
Other nonprofit institutions	..	..	1,169	..	681	1,850	4.9%
Total.	2,920	11,441	18,100	2,721	2,695	37,877	100.0%
Percent distribution, performers	7.7%	30.2%	47.8%	7.2%	7.1%	100.0%	
APPLIED RESEARCH							
Federal Government	5,421	3,087	3,130	1,545	1,144	14,326	28.0%
Industry	..	32,701	567	..	357	33,625	65.6%
Universities and colleges	..	..	2,107	..	..	2,107	4.1%
Other nonprofit institutions	..	..	550	..	613	1,163	2.3%
Total.	5,421	35,788	6,354	1,545	2,114	51,221	100.0%
Percent distribution, performers	10.6%	69.9%	12.4%	3.0%	4.1%	100.0%	
DEVELOPMENT							
Federal Government	8,848	19,686	1,181	1,251	1,403	32,369	23.4%
Industry	..	104,380	124	..	210	104,715	75.8%
Universities and colleges	..	..	463	..	..	463	0.3%
Other nonprofit institutions	..	..	121	..	408	529	0.4%
Total.	8,848	124,066	1,888	1,251	2,021	138,075	100.0%
Percent distribution, performers	6.4%	89.9%	1.4%	0.9%	1.5%	100.0%	

FFRDC = Federally Funded Research and Development Center

NOTE: State and local government funds are included in industry funds reported to industry performers, and in university and college funds reported to university and college performers. Details may not add to totals because of rounding.

[a]Expenditures for FFRDCs administered by both industry and nonprofit institutions are included in the totals of their respective sectors. They are estimated to account for less than 2 percent and 12 percent, respectively, of the industry and nonprofit institutions performance totals. FFRDCs are organizations exclusively or substantially financed by the Federal Government to meet a particular requirement or to provide major facilities for research and training purposes.

[b]FFRDCs administered by individual universities and colleges and by university consortia.

See appendix tables 2-3 , 2-7, 2-11, and 2-15.

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States grew in real terms by 5.8 percent per year between 1994 and 1998, in spite of virtually no real growth (0.6 percent per year) in Federal R&D support. Over the same period, industrial support for R&D grew at a real annual rate of 8.9 percent. Much of this increase might be explained by the favorable economic conditions that generally existed during the period.

Trends in Financial Support for R&D

Federal Support by National Objective

Federal Funding Trends

In recent years the Federal Government has contributed smaller shares of the Nation's R&D funding. The Federal Government once was the main provider of the Nation's R&D funds—accounting for 54 percent in 1953 and as much as 67 percent in 1964. The Federal share of R&D funding first fell below 50 percent in 1979, and it remained between 45 and 47 percent from 1980 to 1988. Since then it has fallen steadily, to 29.5 percent in 1998—the lowest ever recorded in the National Science Foundation's (NSF) data series (which began in 1953).[8] This decline in the Federal share, however, should not be misinterpreted as a decline in the actual amount funded. Federal support in 1998 ($66.9 billion), for example, actually reflects a 2.1 percent increase in real terms over the 1997 level. Because industrial funding increased much faster (see above), however, Federal support as a proportion of the total has continued to decline.

Although the Federal share of total R&D expenditures continued to fall, Federal R&D funding, in absolute terms, actually expanded between 1980 and 1998 (from $30.0 billion to $66.9 billion)—which, after inflation, amounted to a small, real growth rate of 1.0 percent per year. This rate was not uniform across the period, however. From 1980 to 1985, Federal R&D funding grew an average of 6.2 percent in real terms annually. Nearly all of the rise in Federal R&D funding during the early 1980s resulted from large increases in defense spending—as evidenced by figures on the Federal budget authority. (See figure 2-4.) For example, defense activities of the Department of Defense (DOD) and the Department of Energy (DOE) accounted for roughly half of the total Federal R&D budget authorizations in 1980.[9] By 1986, such defense-related activities peaked at 69 percent of the Federal R&D budget authority.

Federal support slowed considerably beginning in 1986—reflecting the budgetary constraints imposed on all government programs, including those mandated by the Balanced Budget and Emergency Deficit Control Act of 1985 (also known as the Gramm-Rudman-Hollings Act) and subsequent legislation (notably the Budget Enforcement Act of 1990, which mandated that new spending increases be offset with specific spending cuts).

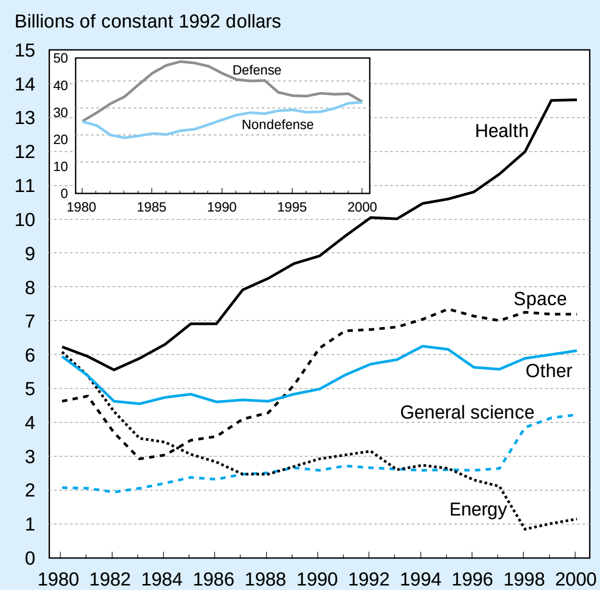
Federal Support by Budget Function

In 1980, the Federal budget authority for defense-related R&D was roughly equal to that for nondefense R&D. As a result of modifications in U.S. security measures in an evolving international arena, defense-related R&D expanded in the early and mid-1980s, coinciding with a decline in nondefense-R&D spending. This defense-related R&D expansion was followed by a period of defense-related R&D reductions in the late 1980s and the 1990s. Nondefense R&D, on the other hand, has been steadily increasing since 1983. For the year 2000, the budget authority for defense R&D and nondefense R&D are roughly equal again, but they are now 28 percent and 29 percent higher in real terms than their respective 1980 levels.

Since 1986, Federal budget authority for civilian-related R&D has grown faster than defense-related R&D. In particular, the budget allocation for health- and space-related R&D increased substantially between FY 1986 and FY 2000, with average real annual growth rates of 4.9 and 5.1 percent, respectively. (Most of the growth in the budget authority for space-related R&D occurred between FY 1986 and FY 1991.) (See figure 2-4.) The budget allocation for defense programs declined by an average real annual rate of 2.5 percent during the same period.

R&D (most of which is development) accounts for 13 percent of all money authorized to be spent by the Federal Government on defense activities in 2000, according to the Federal budget authority. In contrast, R&D accounts for only 3 percent of the Federal nondefense budget authority, though many nondefense functions have much higher proportions. (See text table 2-2.) With regard to nondefense objectives (or "budget functions"), R&D accounts for 73 percent of the funds for general science—nearly all of which (95 percent) is devoted to basic research. (See text table 2-3.) R&D accounts for 67 percent of the funds for space research and technology, most of which (78 percent) is devoted to applied research and development. Among funds for health, R&D represents 10 percent, most of which (54 percent) is devoted to basic research and nearly all of which is directed toward NIH programs.

Figure 2-4.
Federal R&D funding, by budget function



NOTES: "Other" includes all nondefense functions not separately graphed, such as agriculture and transportation. The 1998 increase in general science and decrease in energy resulted from a reclassification.

See appendix table 2-23. *Science & Engineering Indicators – 2000*

[8]The sample design for estimating industry R&D expenditures was revised for 1991 and later years. The effect of the change in industry's sample design was to reduce the Federal share of the national R&D total to 38 percent in 1991, down from the 41 percent share previously published for 1991. For more information on these survey changes and their effects on R&D estimates, see Appendix A in NSF (1999c).

[9]These percentage share calculations of defense-related R&D activities are based on Federal budget authorization totals, not on data reported by the performers of R&D. Although funding is designated in the budget authority, it is actually provided through appropriations, not authorizations. In congressional terminology, authorizations are only guidelines, suggestions, or ceilings for appropriations and do not result in any money actually being spent. Only appropriations can provide money.

21st Century Research Fund and Earlier Concepts

The discussion and statistics on Federal funding of R&D provided in this chapter are based on two economic measures of R&D that have significant historical precedence: the Federal "budget authority" for R&D and accounts of "Federal funds" for R&D. Statistics on the R&D budget authority are provided in the Budget of the United States Government, though more detailed information on the budget authority for R&D is acquired through the NSF survey *Federal R&D Funding by Budget Function.* Statistics on Federal funds for R&D are acquired through the NSF survey *Federal Funds for Research and Development.* These two Federal surveys, along with other NSF surveys of the academic, industrial, and nonprofit sectors, provide the statistical information on R&D levels presented in this chapter.

The budget authority and Federal funds differ in definition. The budget authority is the primary source of legal authorization to enter into financial obligations that will result in outlays. Budget authority is most commonly granted in the form of appropriations laws enacted by Congress with the approval of the President. In contrast, Federal funds are measured in the form of obligations, which represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when the funds were appropriated or when future payments are required.

In recent years, however, alternative concepts have been used to isolate and describe fractions of Federal support that could be associated with scientific achievement and technological progress. In a 1995 report (NAS 1995), members of a National Academy of Sciences committee proposed an alternative method of measuring the Federal Government's science and technology (S&T) investment. According to the committee members, this approach—titled the Federal Science and Technology (FS&T) budget—might provide a better way to track and evaluate trends in public investment in R&D. (This concept was discussed in *Science & Engineering Indicators—1998.*) The FS&T concept differed from Federal funds for research in a variety of ways: It was never defined in precise terms; unlike Federal funds, it did not include major systems development supported by DOD and DOE; and it contained not only research but also some development and some R&D plant.*

In the FY 1999 budget, a new concept—the "Research Fund for America" (RFA)—was introduced, which reflected the Administration's interest in addressing the FS&T concept previously proposed by the Academy. Unlike the FS&T budget, however—which was constructed from components of the R&D budget—the RFA was constructed out of easily-trackable programs and included some non-R&D programs, such as NSF education programs and staff salaries at the National Institutes of Health (NIH) and NSF. The RFA consisted of only civilian (nondefense) R&D; it captured 94 percent of civilian basic research, 72 percent of civilian applied research, and 51 percent of civilian development. With regard to specific Federal agencies, the RFA included R&D supported by the Department of Health and Human Services (HHS), NSF, DOE, the Department of the Interior (DOI), the Environmental Protection Agency (EPA), and the Department of Veterans Affairs; R&D supported by various offices under the Department of Agriculture (USDA), the Department of Commerce (DOC), the National Aeronautics and Space Administration (NASA), and the Department of Education; and R&D associated with the "Climate Change Technology Initiative" interagency project. Not included under the RFA concept was R&D supported by DOD, the Department of Housing and Urban Development (HUD) (not otherwise included in the climate change technology initiative), the Department of Justice (DOJ), the Department of Labor (DOL), and the Department of Transportation (DOT).

The FY 2000 Budget refers to the concept "21st Century Research Fund," which is a slight modification of the RFA. It expands the RFA to include basic and applied research in defense, adds certain programs in transportation, and removes the HUD portion of the climate change technology initiative. Thus, the 21st Century Research Fund includes research supported by HHS, NSF, DOE, NASA, DOD, USDA, DOC, DOI, EPA, the Department of Veterans Affairs, the Department of Education, and DOT but does not include research supported by HUD, DOJ, DOL, the Treasury Department, the Smithsonian Institution, and other agencies with relatively low levels of research support.

The 21st Century Fund's estimated total budget authority for FY 1998, according to the 2000 Budget of the United States Government, is $33.8 billion. It captures approximately 95 percent of total basic research and 75 percent of total applied research. Like the RFA, the 21st Century Fund includes some development funds, as well as the same non-R&D programs as the RFA. Consequently, it is not comparable to total research funding as defined and reported in this chapter.

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*For additional discussion on the differences between R&D, FS&T, and the programs in the 21st Century Fund, see Chapter 6 of AAAS (1999b).

At first glance, the R&D budget authority for energy appears to have declined rapidly in recent years—in particular, from $2.4 billion in 1997 to only $0.9 billion in 1998. (See figure 2-4.) This effect, however, was the result of reclassification, not an actual decline in economic resources devoted to energy R&D. Beginning in FY 1998, several DOE programs were reclassified from "energy" to "general science," so the decline from $2.4 billion to $0.9 billion in energy R&D was offset by an increase in general science from $2.9 billion to $4.4 billion. (See appendix table 2-23.)

Federal Support by Functional Categories

Defense-related R&D, as a proportion of the Nation's total R&D, has undergone substantial shifts. From 1953 to 1959, defense-related R&D rose from 48 percent to 54 percent; it then declined to a relative low of 24 percent in 1980. From 1980 to 1987, it climbed again to 31.8 percent, but then it declined again to a low of 16 percent in 1998.[10] (See figure 2-5.)

[10]These shares by national objective represent a distribution of performer-reported R&D data. They are distinct from the budget authority shares reported above, which are based on the functional categories that constitute the Federal budget.

Text table 2–2.
R&D as a percentage of Federal budget authority, by function: FY 2000

Budget function	Millions of dollars: R&D total (preliminary 2000)	Millions of dollars: Federal total	Percent: R&D share
Total	75,415	1,781,050	4.2
On-budget	75,415	1,441,914	5.2
National defense	37,710	280,800	13.4
Nondefense (on-budget)	37,704	1,161,114	3.2
Health	15,824	155,483	10.2
Space research and technology	8,422	12,509	67.3
Energy[a]	1,348	(2,260)	NA
General science	4,951	6,771	73.1
Natural resources and environment	1,944	23,952	8.1
Transportation	1,840	53,423	3.4
Agriculture	1,522	14,148	10.8
All other	1,853	897,088	0.2

NA = Not applicable

NOTES: Because of rounding, components may not add to totals shown. Data are derived from the Administration's 1999 budget proposal. On-budget totals are for all Federal Government transactions except those of the Social Security trust funds (Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds) and the Postal Service.

[a]The budget authority for Energy is negative because of offsetting receipts from sales of the Strategic Petroleum Reserve.

SOURCES: National Science Foundation, Division of Science Resources Studies, and Office of Management and Budget, *The Budget for Fiscal Year 2000*, Historical Tables, and National Science Foundation/Division of Science Resources Studies, *Federal R&D Funding by Budget Function: Fiscal Years 1998–2000*.

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Text table 2–3.
Budget authority for R&D by function and character of work: Anticipated levels for FY 2000
(Millions of dollars)

Budget function	Basic research	Applied research and development	R&D total
Total	18,101	57,314	75,415
National defense	1,152	36,559	37,710
Nondefense (total)	16,949	20,755	37,704
Health	8,590	7,234	15,824
Space research and technology	1,841	6,581	8,422
Energy	46	1,302	1,348
General science	4,710	241	4,951
Natural resources and environment	175	1,769	1,944
Transportation	634	1,206	1,840
Agriculture	736	786	1,522
All other	218	1,636	1,853

NOTE: Because of rounding, components may not add to totals shown.

SOURCES: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *Federal R&D Funding by Budget Function: Fiscal Years 1998–2000*, and unpublished tabulations.

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Space-related R&D funding, as a percentage of total R&D funding, reached a peak of 22 percent in 1965, during the height of U.S. efforts to surpass the Soviet Union in space travel. It declined after that, to a low of 3 percent in 1984 and 1986. By 1990 it was back up to 4 percent, and it has remained between 4 and 5 percent since. Federal support for nondefense/nonspace R&D programs, as a percentage of total U.S. R&D, has been declining steadily since 1994, when it was 12 percent. It was 10 percent in 1998—the lowest since 1961 (when it was 9 percent).

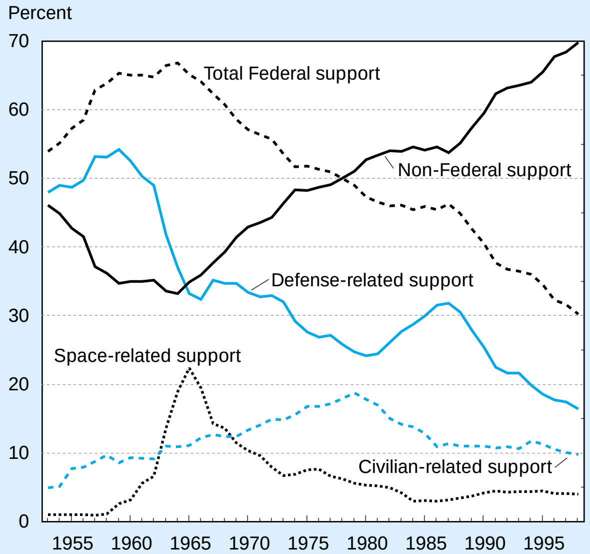
R&D by Federal Agency

According to preliminary data provided by Federal agencies, in FY 1999 DOD was the source of 75 percent of all Federal R&D obligations to industry, excluding industry-administered FFRDCs. (See appendix table 2-38.) Nearly all (94 percent) of these funds supported development work. Two other agencies—NASA and DOE—provide most of the other Federal R&D funds that industry receives.

HHS accounted for 59 percent of all Federal R&D obligations to universities and colleges, excluding university-administered FFRDCs, in FY 1999. Most of HHS's R&D support (56 percent) is directed toward academia; 21 percent is spent internally, mostly in NIH laboratories. HHS also accounts for 67 percent of all Federal R&D obligations for nonprofit organizations in 1999. Approximately 5 percent of HHS R&D obligations go to industrial firms.

NSF and DOD are the other leading supporters of R&D conducted in academic facilities. Eighty-one percent of NSF's

Figure 2-5.
Trends in Federal and non-Federal R&D expenditures as a percentage of total R&D: 1953–98



See appendix table 2-19. *Science & Engineering Indicators – 2000*

R&D budget supports projects at universities and colleges. Most of the remainder is divided among other nonprofit organizations (7 percent), university-administered FFRDCs (6 percent), and industry (5 percent). DOD provides only 4 percent of its R&D support to universities and colleges; it provides 70 percent to industry and 23 percent to Federal intramural activities. In contrast, DOE provides 9 percent of its support to universities, 22 percent to industry, 12 percent to Federal intramural activities, and 37 percent to FFRDCs administered by universities and colleges.

Of all Federal obligations to FFRDCs in FY 1999, DOE accounted for 61 percent, NASA accounted for 18 percent, and DOD accounted for 14 percent. More than half (56 percent) of DOE's R&D support is directed to FFRDCs.

Unlike all other Federal agencies, USDA, DOC, and DOI spend most of their R&D obligations internally. Most of the R&D supported by these agencies is mission-oriented and is conducted in laboratories run by the Agricultural Research Service, the National Institute for Standards and Technology (NIST), and the U.S. Geological Survey (USGS).

Federal R&D obligations are concentrated in a small number of agencies. Six Federal agencies had R&D obligations of more than $1 billion in FY 1998 (out of total Federal R&D obligations of $72 billion). These agencies, in descending order of R&D obligations, are DOD (48.3 percent of the total), HHS (19.02 percent), NASA (13.7 percent), DOE (8.1 percent), NSF (3.3 percent), and USDA (2.0 percent). (See figure 2-6 and text table 2-4.)

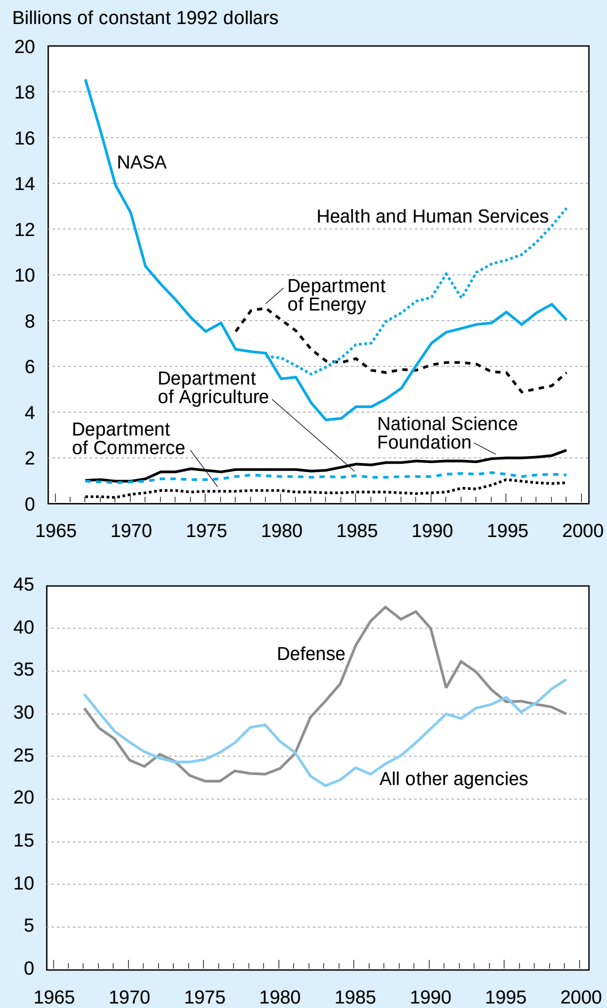
In contrast to total R&D obligations, only three agencies had intramural R&D expenditures that exceeded $1 billion in 1998, including costs associated with planning and administering extramural R&D programs: DOD, HHS (which includes NIH), and NASA. These three agencies together accounted for 81 percent of all Federal R&D obligations for 1998 and 77 percent of Federal intramural R&D.

All agencies, including those that fund R&D, are subject to evaluation and scrutiny according to the Government Performance and Results Act (GPRA) of 1993. (See sidebar, "GPRA and Federal Support for R&D.")

Federal Support to Academia

The Federal Government has long provided the largest share of R&D funds used by universities and colleges. In the early 1980s, Federal funds accounted for roughly two-thirds of the academic total. By 1991, however, that share had dropped to 59 percent, and it has remained between 59 and 60 percent since. Although this share of funding has not changed much in recent years, the actual amount of funding, in real terms, grew an average of 4.8 percent per year between 1985 and 1994 and 2.8 percent between 1994 and 1998. (For more information on academic R&D, see chapter 6.)

Figure 2-6.
National R&D obligations, by selected agency



See appendix table 2-26. *Science & Engineering Indicators – 2000*

GPRA and Federal Support for R&D

In response to the Clinton Administration's effort to move toward a government that works better and costs less, Congress passed the Government Performance and Results Act (GPRA) of 1993. GPRA aims to shift the focus of Federal agencies away from traditional concerns such as staffing and the level of services provided and toward results. Specifically, GPRA seeks to improve Federal planning and management, increase accountability for and assessment of results, and provide better information for congressional and agency decisionmaking. To accomplish these and related goals, GPRA requires every Federal agency to prepare detailed, multiyear strategic plans, annual performance plans, and annual performance reports. These documents give agencies formal tools with which to set forth goals, to prepare plans to meet those goals, and to assess and measure progress and accomplishments on a regular and systematic basis.

GPRA poses a particular challenge for agencies that must assess the scientific research programs they fund. In fact, the General Accounting Office (GAO) has found that measuring the discrete contribution of a Federal initiative to a specific program result is particularly challenging for regulatory programs; scientific research programs; and programs that deliver services to taxpayers through third parties, such as state and local governments (GAO 1997a). Regarding research programs, GAO points out that the amount of money spent on R&D has been used as the primary indicator of how much research is being performed in a given area—but that such an input indicator does not provide a good indication of the outcomes (results) of the research. In a recent report, GAO notes:

> Experts in research measurement have tried for years to develop indicators that would provide a measure of the results of R&D. However, the very nature of the innovative process makes measuring the performance of science-related projects difficult. For example, a wide range of factors determine if and when a particular R&D project will result in commercial or other benefits. It can also take many years for a research project to achieve results…Experiences from pilot efforts made under the Government Performance and Results Act have reinforced the finding that output measures are highly specific to the management and mission of each Federal agency and that no single indicator exists to measure the results of the research (GAO 1997b, 2–3).

The Committee on Science, Engineering, and Public Policy (COSEPUP)—a joint committee of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine—wrote a report titled *Evaluating Federal Research Programs*: *Research and the Government Performance and Results Act* (COSEPUP 1999). As the title suggests, the report addressed how Federally supported research should be evaluated for its compliance with GPRA requirements. According to the report, "Agencies are required to develop a strategic plan that sets goals and objectives for at least a 5-year period, an annual performance plan that translates the goals of the strategic plan into annual targets, and an annual performance report that demonstrates whether targets are met" (COSEPUP 1999, 1).

Through its expert analysis of the nature of Federal research support and its understanding of GPRA requirements, COSEPUP reached the following conclusions:

- Both applied research and basic research…can be evaluated meaningfully on a regular basis.
- Agencies must evaluate their research programs by using measurements that match the character of research.
- The most effective means of evaluating Federally funded research programs is expert review.
- Agencies must pay increased attention to their human-resource requirements in terms of training and educating young scientists and engineers and in terms of providing an adequate supply of scientists and engineers to academe, industry, and Federal laboratories.
- Mechanisms for coordinating research programs in multiple agencies whose fields or subject matters overlap are insufficient.
- The development of effective methods for evaluating and reporting performance requires the participation of the scientific and engineering community, whose members will necessarily be involved in expert review (COSEPUP 1999, 4–8).

In accordance with these findings, COSEPUP made the following recommendations:

- Research programs should be described in strategic and performance plans and evaluated in performance reports.
- For applied research programs, agencies should measure progress toward practical outcomes. For basic research programs, agencies should measure quality, relevance, and leadership.
- Federal agencies should use expert review to assess the quality of research they support, the relevance of that research to their mission, and the leadership of that research.
- Both research and mission agencies should describe in their strategic and performance plans the goal of developing and maintaining adequate human resources in fields critical to their missions both at the national level and in their agencies.
- Although GPRA is conducted agency-by-agency, a formal process should be established to identify and coordinate areas of research that are supported by multiple agencies. A lead agency should be identified for each field of research and that agency should be responsible for assuring that coordination occurs among the agencies.
- The science and engineering community can and should play an important role in GPRA implementation (COSEPUP 1999, 8–11).

Text table 2–4.
Federal R&D obligations, total and intramural by agency: FY 1998

Agency	Total R&D obligations (millions of current dollars)	Total R&D obligations as a share of Federal total (percent)	Intramural R&D (millions of current dollars)	Percent of agency R&D obligations that are intramural[a]	Percent change in real intramural R&D from previous year[b]
Department of Defense	34,832.6	48.30	7,750.6	22.25	–6.1
Dept of Health & Human Services, total	13,717.8	19.02	2,957.2	21.56	9.3
National Aeronautics & Space Admin	9,850.7	13.66	2,462.7	25.00	4.4
Department of Energy	5,833.1	8.09	535.1	9.17	24.3
National Science Foundation	2,356.9	3.27	14.4	0.61	3.9
Department of Agriculture, total	1,441.9	2.00	954.9	66.23	3.0
Department of Commerce, total	978.7	1.36	695.1	71.02	3.4
Department of Transportation, total	664.7	0.92	265.8	39.99	36.8
Department of the Interior, total	613.3	0.85	541.9	88.36	3.3
Environmental Protection Agency	606.0	0.84	289.3	47.74	11.1
Department of Veterans Affairs	299.3	0.42	299.3	100.00	17.0
Department of Education	211.8	0.29	9.8	4.63	5.3
Agency for International Development	183.9	0.26	21.0	11.42	–7.8
Smithsonian Institution	134.0	0.19	134.0	100.00	1.9
Department of Justice, total	102.9	0.14	42.2	41.01	0.2
Department of the Treasury, total	74.2	0.10	45.3	61.05	15.7
Social Security Administration	56.1	0.08	6.3	11.23	24.5
Nuclear Regulatory Commission	50.7	0.07	14.0	27.61	-9.0
Department of Labor, total	46.8	0.06	16.8	35.90	25.8
Dept of Housing & Urban Development	39.6	0.05	25.0	63.13	16.5
U.S. International Trade Commission	5.8	0.01	5.8	100.00	0.5
Tennessee Valley Authority	2.9	0.00	2.9	100.00	–67.8
Library of Congress	2.5	0.00	2.5	100.00	–11.8
Department of State	1.0	0.00	0.3	30.00	–1.2
Other Agencies[c]	6.9	0.01	5.4	78.26	11.2
Entire Federal Government[d]	72,114.1	100.00	17,097.6	23.71	1.0

[a]Intramural activities include actual intramural R&D performance and the costs associated with the planning and administration of both intramural and extramural programs by Federal personnel.

[b]Based on fiscal year GDP implicit price deflators for 1997 and 1998. (See appendix table 2-1.)

[c]Includes: Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, National Archives and Records Administration, U.S. Arms Control and Disarmament Agency, and U.S. Information Agency.

[d]Numbers do not total exactly, due to rounding.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *Survey of Federal Funds for Research and Development: Fiscal Years 1997, 1998, and 1999.*

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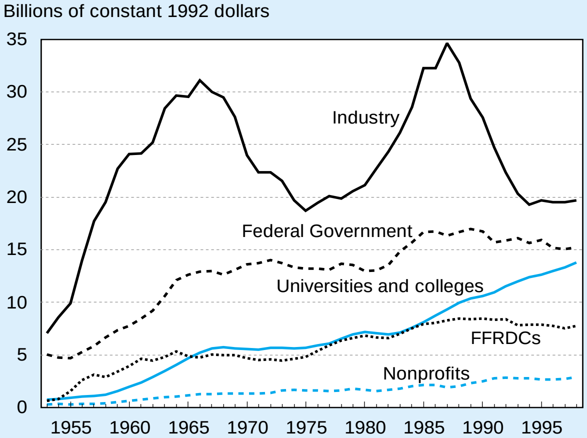
R&D performance in 1998 by university-administered FFRDCs was $5.5 billion, or approximately 2.4 percent of the national R&D effort. These FFRDCs accounted for 17.3 percent of total 1998 academic R&D performance (universities and colleges plus academically administered FFRDCs). From 1974 to 1980, R&D at academically administered FFRDCs grew by 8.5 percent per year in real terms. This increase largely mirrored the Federal emphasis on energy programs. Since 1980, the Federal shift away from energy concerns has resulted in much slower growth in academically administered FFRDC R&D performance—only 1.2 percent per year in real terms.

Federal Funding to Other Sectors

Trends in Federal funding to industry, FFRDCs, and other nonprofit organizations have varied considerably over time. (See figure 2-7.) The greatest fluctuation has been Federal funds to industry (excluding industry-administered FFRDCs), which rose from a low of $7.1 billion (in constant 1992 dollars) in 1953 (at the beginning of a time series)[11] to $31.1 billion in 1966, fell to $18.7 billion in 1975, rose sharply

[11]The 1953 value is actually an overestimate because the 1953 and 1954 figures for Federal support to industry include support to industry-administered FFRDCs, whereas the figures for subsequent years do not. (See appendix table 2-6.)

Figure 2-7.
Federal R&D support, by performing sector



See appendix tables 2-6 and 2-7.

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thereafter to $34.6 billion in 1987, and then fell sharply again to $19.3 billion in 1994. From 1994 to 1998, however, Federal support to industry has been relatively unchanged—ranging from $19.3 to $19.7 billion (in constant 1992 dollars). These trends reflect the historical shifts in Federal priorities on defense-, space-, heath-, and energy-related R&D. (See sidebar, "FY 1998 is Final Year for Tracking of Independent Research and Development Defense Spending.")

Federal funding to FFRDCs and nonprofit organizations has undergone much less fluctuation since 1953. Federal support to nonprofit organizations displayed steady growth overall for the 1953–98 period. Support to FFRDCs grew substantially in real terms between 1955 and 1963, experienced almost no real growth between 1963 and 1981, grew substantially again between 1981 and 1985, and has since experienced a gradual decline in real funding. (See figure 2-7.)

Federal financing for industrial R&D, including industry FFRDCs, has varied markedly across time and across different industries. The Federal Government provided $23.9 billion for industry R&D in 1997 (the most recent year for which detailed data by industrial category are available). Aerospace companies (or the industrial sector "aircraft and missiles") alone received 44 percent of all Federal R&D funds provided to all industries. Consequently, 65 percent of the aerospace industry's R&D dollars came from Federal sources; the remaining 35 percent came from those companies' own funds. In comparison, the drugs and medicines sector in 1997 financed 100 percent of its R&D from company funds; machinery financed 99 percent of its R&D from company funds, professional and scientific instruments financed 67 percent from company funds, transportation equipment other than aircraft and missiles financed 90 percent from company funds, business services financed 97 percent from company funds, and engineering and management services financed 64 percent from company funds.[12]

Federal funding of R&D in aircraft and missiles has declined between 1985 and 1997, both as a percentage of total Federal support to all industries and as a percentage of the aircraft and missiles sector's total R&D. (See figure 2-8.) Nevertheless, the aircraft and missiles sector has continued to receive more Federal support than any other industrial sector in actual dollars. The exact amounts, however, seem somewhat in question. Classifying and tracking Federal support for defense-related industrial R&D appears to be extremely difficult. (See "Accounting for Defense R&D: Gap Between Performer- and Source-Reported Expenditures.")

Federal R&D support for professional and scientific instruments rose sharply between 1988 and 1997—from 0.6 percent of all Federal support to industry to 19 percent of all Federal support. Likewise, Federal support in this area grew from only 3 percent of the sector's total R&D performance in 1988 to 33 percent 1997. (See figure 2-8.)

Interestingly, Federal funds devoted to the nonmanufacturing sector grew from 9 to 17 percent between 1985 and 1997. Because total Federal support to industry declined in real terms over this period, however, Federal support to R&D in nonmanufacturing as a percentage of all R&D in nonmanufacturing declined markedly over the same period—from 34 percent in 1985 to 11 percent in 1997.

Also declining over this period—both as a percentage of the Federal contribution and as a percentage of each of the sectors' total R&D performance—was Federal support for R&D in electrical equipment, transportation equipment other than aircraft and missiles, and machinery. (See figure 2-8.)

Federal Support for Small Business R&D

In addition to traditional government procurement for R&D that tends to be performed by large companies, Federal R&D support is also provided through its Small Business Innovation Research (SBIR) Program. Created in 1982 to strengthen the role of small firms in Federally supported R&D, the SBIR Program presently consists of 10 independently administered Federal agency programs; it is the country's largest merit-based competitive grants program available to small businesses. Through FY 1997, the SBIR Program had directed nearly 46,000 awards worth more than $7.5 billion in R&D support to thousands of qualified small high-technology companies on a competitive basis. Under this program—which is coordinated by the Small Business Administration (SBA) and is in effect until the year 2000—when an agency's external R&D obligations (those exclusive of in-house R&D performance) exceed $100 million, the agency must set aside a fixed percentage of such obligations for SBIR projects. This per-

[12]The 100 percent company funding for the drugs and medicines sector does not include the benefits this sector receives from R&D financed by NIH.

FY 1998 is Final Year for Tracking of Independent Research and Development Defense Spending

In addition to the Federal R&D obligations discussed in this chapter, DOD's Independent Research and Development (IR&D) Program enables industry to obtain Federal funding for R&D conducted in anticipation of government defense and space needs. Because private contractors initiate IR&D themselves, IR&D is distinct from R&D performed under contract to government agencies for specific purposes. IR&D allows contractors to recover a portion of their in-house R&D costs through overhead payments on Federal contracts on the same basis as general and administrative expenses.*

Until 1992, all reimbursable IR&D projects were to have "potential military relevance." Because of the concern that defense cutbacks would reduce civilian R&D—not only in the level of commercial spillovers from weapons research but, more important, in dramatically reduced DOD procurement from which IR&D is funded—the rules for reimbursement have been successively eased and the eligibility criteria broadened. Reimbursement is now permissible for a variety of IR&D projects of interest to DOD, including those intended to enhance industrial competitiveness, develop or promote dual-use technologies, or provide technologies that address environmental concerns. DOD reimbursed $1.6 billion in 1998. (NASA also reimburses firms for IR&D costs, but those amounts are significantly less—about 5 to 10 percent of the DOD reimbursements.) As an equivalent proportion of DOD's direct industrial R&D support, IR&D fell from 12 percent in 1984 to less than 7 percent in 1998, although the latter figure is undoubtedly on the low side as a result of accounting and statistical changes. (See appendix table 2-43.) Prior to 1993, contractors with auditable costs of $40 million or more were included in the IR&D statistics. Since then, the threshold has included only firms with auditable costs of more than $70 million. As a result of auditing and reimbursement policy changes that allow practically all of industry's IR&D claims, future collection of IR&D data is not expected.

*In national statistics on R&D performance and funding, industrial firms are requested to report IR&D expenditures as industry-funded, industry-performed R&D. Ultimately, firms expect to be reimbursed for most—but not all—of these expenditures. Federal agencies do not include IR&D obligations in their reported R&D totals. For example, IR&D reimbursements to industry are paid out of DOD's procurement accounts, not its research, development, test, and evaluation (RDT&E) accounts.

centage initially was set at 1.25 percent, but under the Small Business Research and Development Enhancement Act of 1992, it rose incrementally to 2.5 percent by 1997.

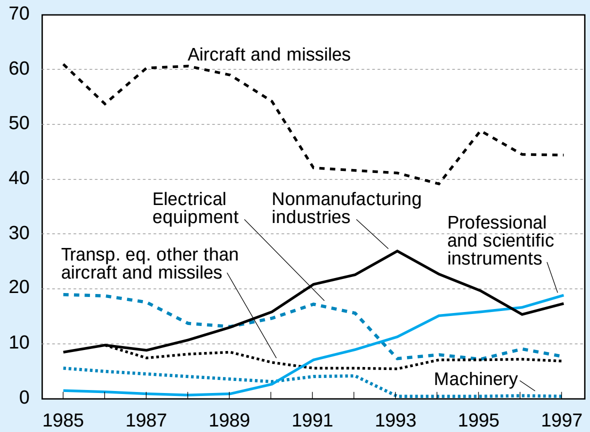
To obtain funding, a company applies for a Phase I SBIR grant. The proposed project must meet an agency's research needs and have commercial potential. If approved, grants of up to $100,000 are made to allow evaluation of the scientific and technical merit and feasibility of an idea. If the concept shows potential, the company can receive a Phase II grant of up to $750,000 to develop the idea further. In Phase III, the innovation must be brought to market with private-sector investment and support; no SBIR funds may be used for Phase III activities.

Ten Federal agencies participated in the SBIR Program in 1997, making awards totaling $1.1 billion—an amount equivalent to 1.6 percent of all government R&D obligations (2 percent of Federally funded R&D performed outside of government labs). The total amount obligated for SBIR awards in 1997 was 20 percent more than in 1996—a result of legislatively required increases in R&D amounts agencies must earmark for SBIR. Since 1992, SBIR funding has more than doubled, while total Federal R&D funding has increased by just 5 percent. In FY 1997, 74 percent of total SBIR funds were disbursed through Phase II grants, although 71 percent of the grants awarded were Phase I grants (3,371 of 4,775 awards). Approximately 51 percent of all SBIR obligations were provided by DOD, mirroring this agency's share of the Federal R&D extramural funding total. (See appendix table 2-44.)

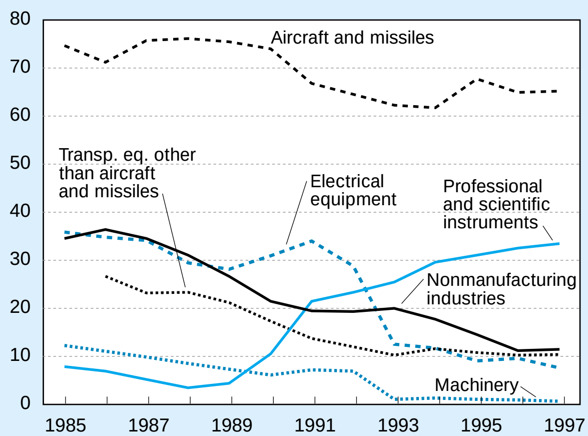
Except for evaluations undertaken by GAO, there have been few independent assessments of the overall effectiveness of the SBIR Program. Where such assessments do exist, however, there is general agreement that the quality of funded research proposals is high and that the value of the program in fostering small business technology-led economic growth is apparent. (See, for example, GAO 1997a and 1998.) In a recent assessment of program administrators' perspectives on SBIR strengths and weaknesses, Federal and state partners agreed that SBIR is invaluable as an effective catalyst for the development of technological innovations by small businesses. Indicative of this viewpoint, all but two states—Kentucky and Pennsylvania—currently have some structured SBIR promotion or assistance effort underway (SSTI 1999b). Most state initiatives focus on the early stages of the SBIR process—for example, creating awareness of the program and supporting pre-Phase 1 activities. (See text table 2-5.)

SBA classifies SBIR awards into various technology areas. In terms of all SBIR awards made during the 1983–97 period, the fine technology areas receiving the largest (value) share of awards were advanced materials, electronics device performance, electromagnetic radiation, and computer communications systems. More broadly, more than one-fourth of all awards made from 1983 to 1997 were electronics-related, and roughly one-sixth involved computers. (See figure 2-9.) Computer- and electronics-related projects received more than 70 percent of their support from DOD and NASA. One-seventh of all SBIR awards went to life sci-

Figure 2-8.
Federal support for R&D in selected industries as a percentage of all Federal support to industrial R&D



Federal support for R&D in selected industries as a percentage of all total R&D performed in those industries



See appendix tables 2-53, 2-54, and 2-55.

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Text table 2–5.
Number of states offering different types of SBIR assistance and services: 1998

Stage in the SBIR Program	Service or Activity	Number
Awareness	Outreach conference	45
	Information clearinghouse	37
	Website	35
	Proactive topic match	18
	Marketing & press release	17
	SBIR newsletter	10
Phase 0	Proposal writing workshops	37
	Proposal assistance	31
	Proposal critique	30
	Reactive topic match	22
	Project team assembly	21
	Literature searches	16
	Phase 0 grants	11
	Marketing topics to agencies	10
Phase I	Trouble shooting for winners	20
	Mentor networks	16
	Winner recognition	11
	Local focus groups	6
	Phase 1 matching funds	5
Pre-Phase II	Strategic alliances	28
	Bridge financing	8
Phase II and beyond	Commercialization assistance	25
	Technology transfer	19
	Phase III investments	5
	Phase II matching funds	2

SOURCE: State Science and Technology Institute (SSTI), *State and Federal Perspectives on the SBIR Program*, Westerville, OH: SSTI, 1999.

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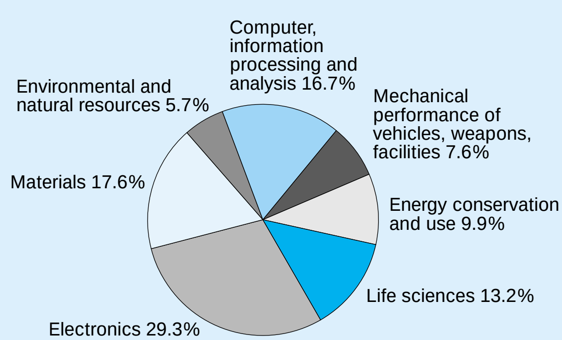
ences research; the bulk of this funding was provided by HHS (SBA 1998).

U.S. Federal and State R&D Tax Credits

Federal R&D Tax Credits

The U.S. government has tried various policy instruments in addition to direct financial R&D support to indirectly stimulate corporate research spending. Proponents of such measures commonly note that, especially as Federal discretionary spending for R&D is squeezed, incentives must be used to invigorate U.S. investment in private-sector innovation to expand U.S. global leadership in high technology. The most notable of these efforts have been tax credits on incremental

Figure 2-9.
Small business innovation research awards, by technology area: 1983–97



SOURCE: Small Business Administration, Annual Report–FY 1997.

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research and experimentation (R&E) expenditures.[13] The credit was first put in place in 1981; it has been renewed nine times, most recently through the end of June 1999.[14] Although the computations are complicated, the tax code provides for a 20 percent credit for a company's qualified R&D amount that exceeds a certain threshold.[15] Since 1986, companies have been allowed to claim a similar credit for basic research grants to universities and other qualifying nonprofit institutions, although otherwise deductible R&E expenditures are reduced by the amount of the basic research credit. This basic research provision generally has gone unutilized.[16]

According to a report prepared for the Joint Economic Committee of the U.S. Congress (based on information from the Internal Revenue Service Statistics of Income publications), more than 12,000 firms use the tax credit (Whang 1998b). From tax years 1991 through 1995 (the latest year of available data), an average of 12,472 firms filed claims totaling $1.85 billion each year, although not all claims are allowed and not all of the allowed credits can be taken immediately. (Thus, the dollar value of R&E tax credits actually received by firms is unknown.) In dollar terms, the largest credits are claimed by large manufacturers—especially pharmaceuticals, motor vehicles, aircraft, electronics and computer firms. Companies with more than $250 million in assets account for three-quarters of the dollar value of all credit claims. On the other hand, three-quarters of credit claimants have assets of $25 million or less, and many claims are filed by medium-sized manufacturers and service providers.

Budget Impact of Federal Tax Credits

To determine the budgetary effect of the credit, the Treasury Department annually calculates estimates of foregone tax revenue (tax expenditures) resulting from preferential tax provisions, including the R&E tax credit. As one such measure, Treasury provides outlay-equivalent[17] figures that allow a comparison of the cost of this tax expenditure with the cost of a direct Federal R&D outlay. Between fiscal years 1981 and 1998, an outlay-equivalent of more than $32 billion was provided to industry through this indirect means. For FY 1998 alone, Treasury calculates an outlay-equivalent of $3.3 billion from the R&D tax credit. Consequently, these credits were equivalent to about 3.2 percent of direct Federal R&D support for the entire 1981–98 period and a record 4.7 percent of direct Federal obligations in FY 1998. (See figure 2-10 and appendix table 2-45.)

State R&D Tax Credits

The Federal Government is not the only source of fiscal incentives for increasing research. According to a survey of the State Science and Technology Institute (SSTI 1997a), 35 states offered some type of incentive for R&D activity in 1996. Many states offered an income tax credit modeled after the Federal R&E credit guidelines. Fifteen states applied the Federal research tax credit concepts of qualified expenditures or base years to their own incentive programs, although they frequently specified that the credit could be applied only to expenditures for activities taking place within the state. Other types of R&D incentives included sales and use tax credits and property tax credits.

[13]Not all R&D expenditures are eligible for such credit, which is limited to expenditures on laboratory or experimental R&D.

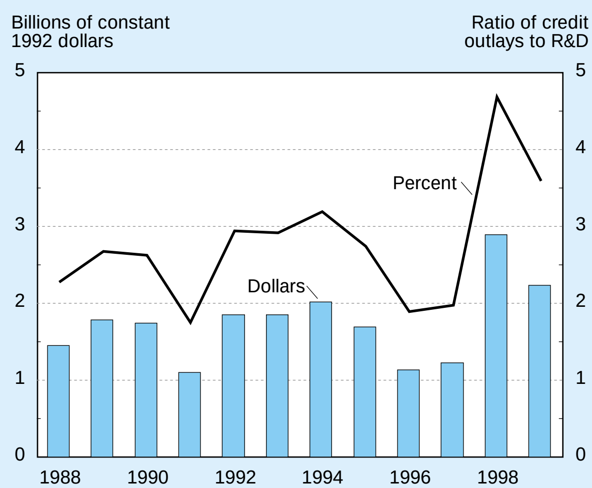
[14]Simply knowing whether the tax credit is in effect is a formidable challenge. Annual extensions have become the norm, and credits are often reinstated retroactively one or two months after the credit expires. At this writing, provision for the tax credit had once again lapsed, but congressional indications were that the credit would be renewed again, retroactively to July 1, 1999, and perhaps with a five-year extension.

[15]The complex base structure for calculating qualified R&D spending was put in place by the Omnibus Reconciliation Act of 1989. With various exceptions, a company's qualifying threshold is the product of a fixed-base percentage multiplied by the average amount of the company's gross receipts for the four preceding years. The fixed-base percentage is the ratio of R&E expenses to gross receipts for the increasingly distant 1984–88 period. Special provisions cover startup firms. An alternative credit was established in 1996 that is not dependent on a firm's incremental R&D. Instead, a 1.65 percent to 2.74 percent credit is awarded for all research expenses exceeding 1 percent of sales. The marginal value of this credit has provided minimal incentive for firms (Whang 1998a).

[16]In 1992 (the latest year for which any such data exist), firms applying for the R&E credit spent about $1 billion on research performed by educational and scientific organizations. After accounting for various qualification restrictions, the basic research credit contributed less than $200 million toward the R&E tax credit (OTA 1995; Whang 1998a).

[17]Specifically, the "outlay-equivalent" measure is the amount of outlay that would be required to provide the taxpayer the same after-tax income as would be received through the tax preference. These amounts tend to be greater than estimates of Federal "revenue losses" from the credit because the outlay program increases the taxpayer's pre-tax income.

Figure 2-10.
Budgetary impact of Federal research and experimentation tax credit: FYs 1988-99



See appendix table 2-45.

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State Government Support for R&D

The pivotal role of state governments in expanding regional economic growth through science and technology (S&T) development is a widely recognized, albeit relatively recent, phenomenon. Almost all states have established lead S&T offices; the existence of most of these offices can be traced only to the mid- to late 1980s (NSB 1991). During the 1990s, states increasingly have included an S&T component in their economic development plans. Many states have adopted statewide S&T strategic initiatives of varying levels of sophistication and complexity (SSTI 1997b). A review of "State of the State" speeches, inaugural addresses, and budget messages delivered by most governors in the early part of 1999 indicates a continuing high level of interest in S&T-based economic development (SSTI 1999a). Common to these plans is the acknowledged importance of:

- Maintaining and strengthening the R&D capacity of the states' colleges and universities;
- Encouraging "home grown" businesses by providing support to entrepreneurs and small technology-based firms; and
- Facilitating the incorporation of new technology into processes and products.

States have become particularly adept at leveraging funds and fostering university-industry partnerships.

NSF has sponsored intermittent surveys of state governments' R&D expenditures dating to the mid-1960s. Over the past 30 years, growth in state R&D support is readily apparent; it generally has been proportionate to changes in other R&D indicators. (See text table 2-6.) Between 1965 and 1995, total state R&D spending increased at an inflation-adjusted average annual rate of 3.3 percent, compared with nationwide R&D spending growth of 2.5 percent per year (NSF 1999d). State sources of state R&D spending grew by 3.4 percent annually, from $732 million (1992 dollars) in 1965 to $2.010 billion (1992 dollars) in 1995. Most of the remaining funds derived from Federal agency support to state agencies. In 1995, state sources for R&D expenditures were equivalent to 1.18 percent of total R&D spending in the United States—a figure similar to the percentages estimated for 1987 and 1977 (1.20 and 1.21 percent, respectively) and somewhat higher than the 1965 estimate (of 0.9 percent). As a percentage of GDP, state sources for R&D have ranged narrowly between 0.025 and 0.032 percent during the 1965–95 period for which there are data. These data also show that universities historically have received the lion's share of state-funded R&D. In 1995, 80 percent of all state R&D funds from state sources supported university activities—only slightly higher than their estimated 78 percent share in 1965.

According to a report by Battelle and the State Science and Technology Institute (Battelle/SSTI 1998), 45 percent of all R&D funds from state sources ($2.431 billion) in 1995 were in support of the "science and technology base" ($1.088 billion), which includes research capacity building. (See text table 2-7.) These funds were spent predominately in support of university-based research. The only functional categories other than "science and technology base" to receive 10 percent or more of states' R&D funds were "food, fiber, agriculture" ($305 million) and "health" ($244 million). Universities

Text table 2–6.
Trends in state government R&D expenditures
(Billions of constant 1992 dollars[a])

	1965	1977	1987	1995
Total state R&D spending[b]	0.884	1.451	2.093	2.336
State sources	0.732	1.112	1.830	2.010
Federal sources	0.144	0.299	0.242	0.240
Non-government sources[c]	0.008	0.040	0.020	0.086
State R&D indicators (percent)				
State R&D/U.S. R&D	1.09	1.58	1.37	1.37
State sources/U.S. R&D	0.90	1.21	1.20	1.18
State R&D/U.S. GDP	0.031	0.034	0.037	0.035
State sources/U.S. GDP	0.025	0.026	0.032	0.030

NOTE: Because of rounding, details may not add to totals. Excludes expenditures on R&D plant. Annual survey data in this table were adjusted data to permit direct comparisons.

[a]GDP implicit price deflators used to convert current dollars to constant dollars.

[b]Includes all funds under state government control. These include state sources such as direct appropriations and funds generated from state bonds, funds from the Federal Government that pass through state agencies, and leveraged funds from industry and other non-government sources.

[c]Non-government sources include industry and other non-state, non-Federal sources such as donations, endowments, and gifts from private individuals or foundations.

SOURCE: National Science Foundation, Division of Science Resources Studies, *What is the State Government Role in the R&D Enterprise?* Arlington, VA: 1999.

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Text table 2–7.
State sources of R&D expenditures, by functional purpose: FY 1995

	($ millions)	Percent
Total	2,431.1	100.0
Science & technology base	1,087.7	44.7
Food, fibre, agriculture	305.4	12.6
Health	243.7	10.0
Economic development	192.1	7.9
Other functions, n.e.c.	158.4	6.5
Environment	110.1	4.5
Education	101.9	4.2
Transportation	80.9	3.3
Natural resources	78.7	3.2
Energy	44.1	1.8
Community development	16.8	0.7
Income security/social services	9.4	0.4
Crime prevention/control	1.9	0.1

SOURCE: Battelle Memorial Institute and State Science and Technology Institute, *Survey of State Research and Development Expenditures FY 1995*. Columbus, OH: Battelle/SSTI, 1998.

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were the primary recipients for funding in both of these categories. "Health" was the single largest functional focus of R&D performed by state agencies; almost 25 percent of the $244 million state-funded state-performed R&D was health-related. R&D explicitly related to "economic development" accounted for 8 percent ($192 million) of total state R&D funding in 1995. Reflecting recent trends to use R&D in support of local business and economic growth, however, "economic development" accounted for 38 percent of state R&D funds to industry ($33 million of the $87 million provided) and 53 percent of state R&D funds to nonprofit organizations ($55 million of $105 million). By comparison, the functionally equivalent category of "economic growth and productivity" accounted for only 5 percent of state funding for R&D to all performers in 1987 and for 2.2 percent of total in 1977 (NSF 1999d).

Historical Trends in Non-Federal Support

R&D financing from non-Federal sources grew by 5.9 percent per year (controlling for inflation) between 1953 and 1980. Between 1980 and 1985, concurrent with gains in Federal R&D spending, it grew at an even faster rate of 7.4 percent per year in real terms. It then slowed to 4.1 percent between 1985 and 1990 and 2.9 percent between 1990 and 1995, but it was back up to 8.4 percent for the 1995–98 period.

Most non-Federal R&D support is provided by industry. Of the 1998 non-Federal support total ($160.2 billion), 93.4 percent ($149.7 billion) was company funded, representing a 8.7 percent increase over its 1997 level in real terms. Industry's share of national R&D funding first surpassed that of the Federal Government in 1980; it has remained higher ever since. From 1980 to 1985, industrial support for R&D, in real dollars, grew at an average annual rate of 7.6 percent. This growth was maintained through the mild 1980 recession and the more severe 1982 recession. (See figure 2-1.) Key factors behind increases in industrial R&D have included a growing concern with international competition, especially in high-technology industries; the increasing technological sophistication of products, processes, and services; and general growth in defense-related industries such as electronics, aircraft, and missiles.

Between 1985 and 1994, growth in R&D funding from industry was slower, averaging only 2.8 percent per year in real terms. This slower growth in industrial R&D funding was only slightly greater than the real growth of the economy over the same period (in terms of real GDP), which was 2.4 percent. In contrast, from 1994 to 1998, industrial R&D support grew in real terms by 8.9 percent per year, compared with a 3.4 percent growth rate for the economy overall.

As one might expect, however, growth of industrial R&D varied significantly among different industrial sectors.[18] The largest sectors in recent years have been chemicals and allied products, electrical equipment, machinery, nonmanufacturing, and transportation equipment. (See appendix tables 2-53 and 2-54.) Between 1985 and 1997, the industrial sectors with the highest rates of annual growth in real R&D performance, from non-Federal sources, have been nonmanufacturing (14.7 percent); paper and allied products (4.9 percent); electrical equipment (4.7 percent); and lumber, wood products, and furniture (4.3 percent). Industries experiencing the greatest annual declines (or negative growth) in R&D over the same period were stone, clay, and glass products (–5.3 percent); petroleum refining and extraction (–5.3 percent); primary metals (–2.5 percent); and food, kindred, and tobacco products (–0.9 percent). (See appendix table 2-54.)

R&D funding from other non-Federal sectors—academic and other nonprofit institutions and state and local governments—has been more consistent over time. It grew in real terms at average annual rates of 5.2 percent between 1980 and 1985, 8.2 percent between 1985 and 1990, 2.3 percent between 1990 and 1995, and 3.9 percent between 1995 and 1998. The level of $10.6 billion in funding in 1998 was 4.8 percent higher in real terms than the 1997 level. Most of these funds have been used for research performed within the academic sector.

Trends in R&D Performance

U.S. R&D/GDP Ratio

Growth in R&D expenditure should be examined in the context of the overall growth of the economy because, as a part of the economy itself, R&D is influenced by many of the same factors. Furthermore, the ratio of R&D expenditures to GDP may be interpreted as a measure of the Nation's commitment to R&D relative to other endeavors.

A review of U.S. R&D expenditures as a percentage of GDP over time shows an initial low of 1.36 percent in 1953 (when the NSF data series began), rising to its highest peak

[18]For studies of patterns of technological change among different industrial sectors, see, for example, Nelson (1995); Pavitt (1984); Utterback (1979).